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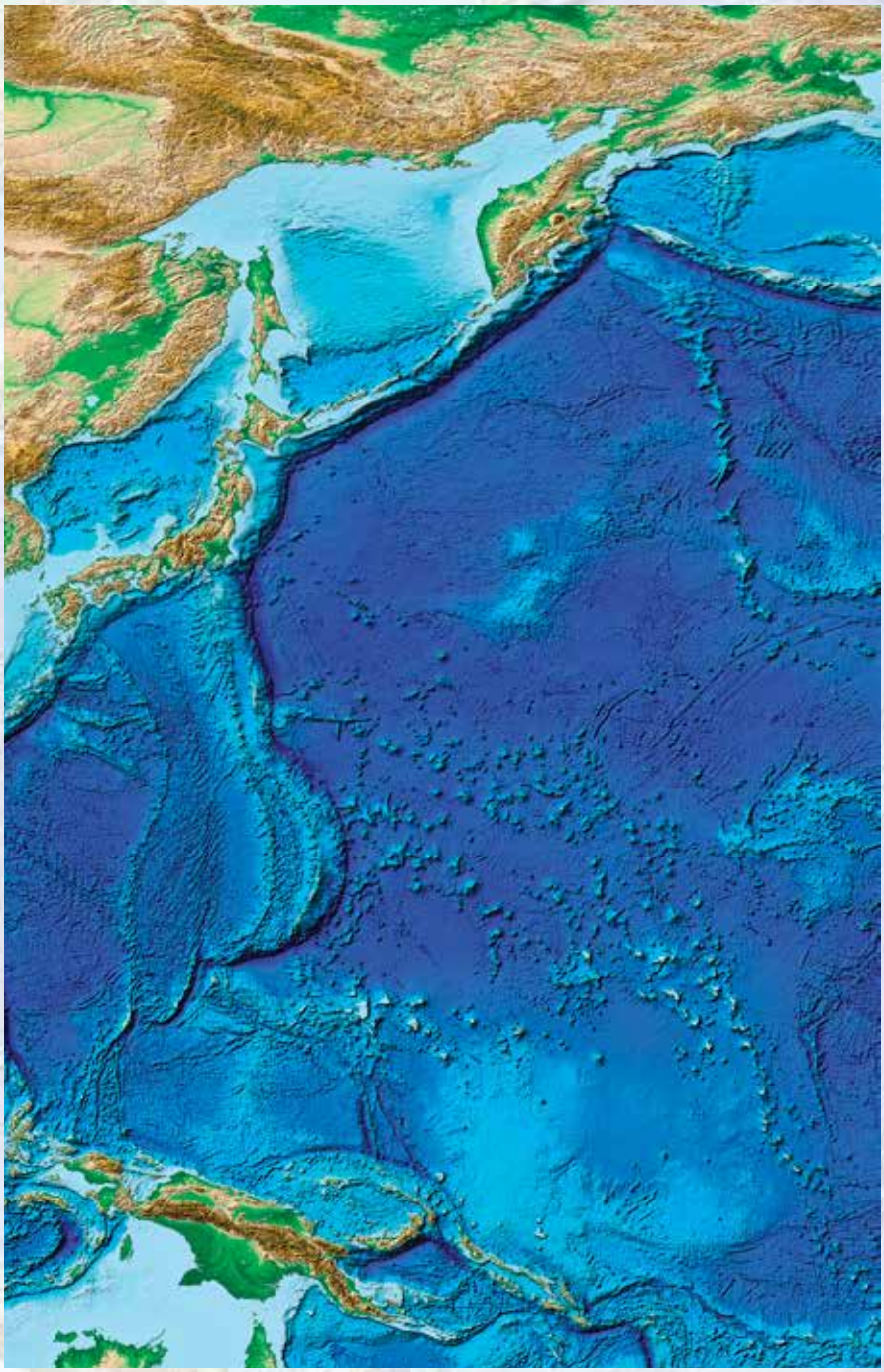

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GSA TODAY

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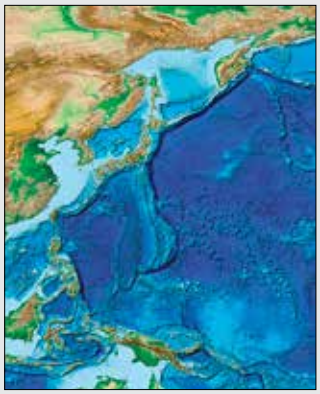

Cover: Bathymetry and topography of a section of the Western Pacific Ocean showing several prominent arc-trench systems of recent interest for their evolution and associated hazards (Izu-Bonin-Mariana, Japan, Nankai, Kurile, and Aleutian). Image courtesy NOAA: www.ngdc.noaa.gov/mgg/global/global.html. See related article, p. 4–10.

GSA News

THE GEOLOGICAL SOCIETY OF AMERICA®

Twenty Years of Subduction Zone Science: *Subduction Top to Bottom 2 (ST2B-2)*

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ABSTRACT

No other plate-tectonic setting has attracted such diverse, multidisciplinary research as convergent margins. Understanding the dynamics of subduction is particularly important for realistic assessment of associated hazards such as earthquakes, tsunamis, and volcanic eruptions. A number of recent initiatives have been successful in building communities not only to investigate subduction processes, but also to convey knowledge about subduction zone processes to other scientists, students, postdocs, and the broader public. These efforts must include synthesizing and simplifying subduction-zone science for classroom presentations and to help prepare the public for subduction-related disasters.

Tremendous advances over the past 20 years or so have been made in subduction zone science, with increasingly multidisciplinary efforts producing some of the greatest insights. We have initiated a publication effort in the GSA journal *Geosphere*, with a Themed Issue "Subduction Top to Bottom 2" (or "ST2B-2") aimed at showcasing the recent advances, following up on the conceptually similar *Subduction Top to Bottom* published in 1996 as an American Geophysical Union Geophysical Monograph. The ST2B-2 *Geosphere* Themed Issue is accumulating papers and is open to ALL wishing to contribute to this effort—we anticipate accepting manuscripts through all of 2018 and possibly beyond.

INTRODUCTION

Subduction is a uniquely powerful and important Earth process, so it is no surprise that the geoscientific community has become increasingly interested in the process since the term was introduced by White et al. (1970; also see the prescient sketch of a subduction zone by Coats, 1962) on the heels of the plate tectonic revolution. Subduction zones are where lithosphere is recycled into the mantle and they provide the third dimension for the ~55,000 km length of convergent plate margins. The sinking of lithosphere in subduction zones provides most of the power for plate motions and is directly responsible for crustal deformation and arc magmatism. Convergent margin processes affect climate directly (volcanic gasses) and indirectly (producing relief and stimulating weathering), contributing importantly to maintaining Earth's habitability, at the same time producing societal benefits (ore deposits and hydrocarbon-rich basins) and some of the most dangerous natural hazards (earthquakes, tsunamis, and explosive volcanism). In spite of their importance, subduction zones are not easy to study because they are hidden deeply in the Earth; teasing out their secrets has involved years of efforts by geologists, geophysicists, and geochemists from many different countries working on land, at sea, and using observations from space. The enormity of the challenge of studying subduction zones has spurred efforts to build a cross-disciplinary community of government, academic, and industrial geoscientists from many nations, and for members of this community to learn how to explain their findings to scientists with different expertise as well as to students and the public. Workshops and edited volumes play key roles in building this community. An excellent early example of this community-building effort was held 23 years ago, and the success of this workshop and the resultant publication encourages continued efforts along these lines.

"SUBCON" (Subduction Conference) was held in Avalon, Santa Catalina Island, California, USA, on 12–17 June 1994, largely funded by the United States Geological Survey (USGS) but with additional support from the National Science Foundation (NSF). At this conference, ~120 scientists from around the world shared their understanding of subduction zone dynamics as a function of depth—from top to bottom—bringing together observations and predictions from the many diverse perspectives of the group. Although it is now common to see multidisciplinary groups working together to understand subduction, this was not so in the mid-1990s. To many at SUBCON, the audience to which they revealed their work was unusually diverse in interests and expertise, resulting in some surprising and useful feedback. As a part of SUBCON, the group visited selected outcrops of the Catalina Schist exposed on the island and, for many of the participants, this was a first view of an ancient subduction zone. SUBCON and its aftermath helped lead to some very productive multidisciplinary collaborations, including the 1996 publication of *Subduction Top to Bottom* (Bebout et al., 1996, American Geophysical Union [AGU] Geophysical Monograph 96, sometimes called "Big Purple" because of the cover). Big Purple contains 39 papers of either a review or case-study nature covering all aspects of subduction zones and their products.

In the 20 or so years since SUBCON and Big Purple, many advances have been made in the fields of geophysics, petrology, geochemistry, and geodynamics, with the work increasingly conducted by highly

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multidisciplinary groups. Understanding of subduction dynamics has greatly benefited from this approach, leading to an increasingly sophisticated view of subduction zones and how they evolve. More comparative studies have also helped to move the community away from thinking that each convergent margin segment is unique and toward seeing subduction as the central problem, with individual margins showing different variations—and thus opportunities for insights—on the unifying theme. As we've examined individual margins in greater detail and contrasted them with other margins, patterns have emerged that reveal some of the controls on convergent margin behavior and evolution. In fact, quite a number of modern subduction margins show dramatic along-strike variations in key physical factors influencing their thermal and mechanical evolution. A few of these factors are convergence rate and obliquity; age of incoming plate and the subduction zone itself; physical, thermal, and chemical state of the subducting oceanic lithosphere; presence of seamounts and other heterogeneities on the downgoing plate; the nature and thickness of subducting sediments; accretion versus erosion; and the composition and structure of the upper plate.

Understanding of the dynamics of subduction is of particular importance in assessing the associated hazards of earthquakes, tsunamis, and volcanic eruptions. The scientific community, governments, and the broader public increasingly recognize the need to assess hazards that subduction margins pose, especially to regions of high population densities around the Pacific and Indian Oceans (e.g., Japan, Indonesia, the Cascadia margin). Recent initiatives promoting this effort include community-led NSF initiatives such as MARGINS and its successor GeoPRISMS, in each of which subduction-zone science has constituted a major component. The two initiatives have identified "focus sites" where effort was concentrated, and these included MARGINS Subduction Factory and SEIZE (SEIsmogenic ZonE) efforts in Central America, Izu-Bonin-Mariana, and Nankai, and GeoPRISMS Subduction Cycles and Deformation focus sites of the Cascadia, Aleutian/Alaska, and New Zealand subduction zones. The MARGINS-sponsored Theoretical Institute, "Inside the Subduction Factory," in 2000 was a particularly important milestone, resulting in AGU Geophysical Monograph 138 (J. Eiler, ed., 2003). Major efforts similar to MARGINS and GeoPRISMS have been undertaken by subduction communities in Japan, Europe, New Zealand, Central and South America, and southeast Asia, resulting in significant investment in subduction zone science by their respective national governments.

This is an exciting time for those interested in understanding subduction margins! In addition to the GeoPRISMS initiative, the U.S. subduction science community is discussing the potential of a "Subduction Zone Observatory," which is presented in a "SZ4D Initiative" report aimed at revealing the short- and long-term evolution of subduction margins. That report resulted from an NSF-sponsored workshop in 2016 that was attended by 250 scientists from the USA and 22 foreign countries (https://www.iris.edu/hq/workshops/2016/09/szo_16). The SZ4D Initiative, as presently configured, proposes three key components: a modeling component, an interdisciplinary science program, and a community infrastructure program (see McGuire et al., 2017). Its science "net" is cast widely, with the aim of fostering integrated geophysics, geology, petrology, geochemistry, and geodynamic modeling. Planning for future subduction zone studies is also being undertaken by the USGS, which has recently announced a major directive, "Reducing Risk Where Tectonic Plates Collide—A Plan to Advance Subduction Zone Science" (https://www.usgs.gov/news/usgs-publishes-a-new-blueprint-can-help-make-subduction-zone-areas-more-resilient; Gomberg et al., 2017). As its name implies, this initiative aims to focus geological, geophysical, and petrologic/geochemical investigations and modeling at understanding and forecasting hazards associated with subduction plate boundaries. Naturally, the Cascadia margin figures prominently in this planned endeavor because of the large earthquake, tsunami, and volcanic hazards it poses to the increasingly populated Pacific Northwest region. Another example of an initiative emphasizing study of subduction processes and hazards is the ZIP project (Zooming in between Plates), which is a collaborative research and training project funded by the European community as a European Marie Curie Initial Training Network (http://www.zip-itn.eu/). This project involves 12 Ph.D. students and two postdoctoral fellows in a network comprising twelve leading international universities and research centers and nine industrial partners. The U.S. GeoPRISMS E-FIRE project (ExTerra Field Institute and Research Endeavor: Western Alps; http://geoprisms.org/exterra/e-fire/), funded by the NSF's PIRE program (Partnerships in International Research and Education), builds on the success of ZIP, providing support for eight Ph.D. students and two postdoctoral fellows at 10 academic institutions.

WHAT HAVE WE LEARNED ABOUT SUBDUCTION IN THE PAST TWENTY YEARS?

As a thought exercise for this report, each of the co-authors assembled a list of what they consider to be the greatest advancements in subduction zone science in the past two decades since SUBCON/Big Purple. Several themes were repeated on our lists and we agreed on the following. This list can of course be quibbled with, but it does capture how exciting subduction science has been and the range of approaches that are being used and the diverse research communities that have been involved:

Some Advances in Subduction Zone Science in the Past 20 Years

- Improved understanding of how new subduction zones form (see the review by Stern and Gerya, 2018);
- The importance of outer rise normal faulting and deep hydration of subducted lithospheric mantle, and the connection with deep-seated seismicity (e.g., Ranero et al., 2005; Van Avendonk et al., 2011; Fig. 1);
- Understanding the magnitude and significance of subduction erosion; that most convergent margins lose material from the upper plate and only a minority add material by growing accretionary prisms (e.g., Scholl and von Huene, 2007);
- Exploration of submarine arc and back-arc basin volcanoes and associated hydrothermal systems and volcaniclastic sedimentation, especially in the Izu-Bonin-Mariana and Tonga Kermadec systems (e.g., Baker et al., 2008; Dziak et al., 2015);
- Recent major subduction earthquakes (such as the 2004 Sumatra and the 2011 Tohoku-Oki earthquakes) have taught us important lessons about what is possible

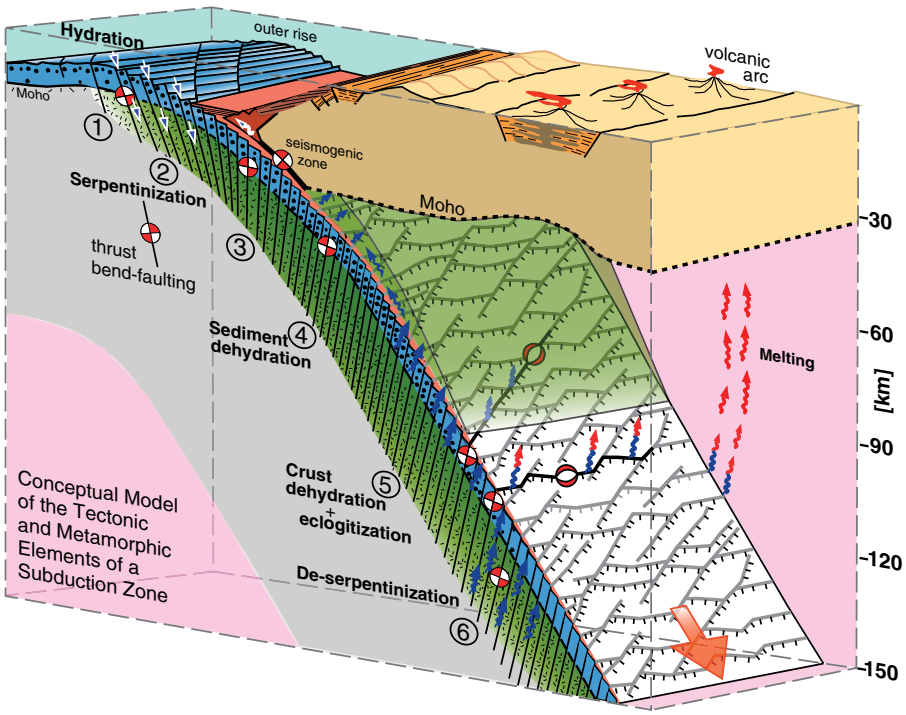

Figure 1. Cartoon showing a conceptual model of the structure and metamorphic evolution of subducting lithosphere formed at a fast spreading center (from Ranero et al., 2005). The topography of the plate in the outer-rise/trench region has been exaggerated to better show the deformation associated with plate bending. Scale is otherwise approximately correct. Fault plane solutions of earthquakes are projected into the top of the slab and the plane of the cross section. The small black-filled circles in oceanic crust indicate hydration.

in these great events. For example, completely unexpected and massive near-trench slip (up to 50 m) in the 2011 Tohoku-Oki earthquake (Fujiwara et al., 2011) has important implications for tsunamigenesis and the nature of slip near the trench;

- Discovery of slow-slip events in subduction zones, and the spectrum of seismological and geodetic phenomena related to slow slip (see Fig, 2, which is from Gomberg et al., 2010). Densification of continuous GPS networks above many subduction zones has been especially important in this effort (see the discussion by Gomberg et al., 2017);
- Statistical and observational documentation that high-magnitude megathrust earthquakes may be linked to where wide expanses of thick sediment and bathymetrically smooth seafloor enter subduction zones (e.g., Brizzi et al., 2018), while subduction margins with rough incoming plates and low sedimentary thicknesses appear to be dominated by aseismic creep and more moderate-sized earthquakes (Wang and Bilek, 2011);
- Increased appreciation of the role that fluids play in subduction margin mechanics and seismogenesis (Saffer and Tobin, 2011);
- Seismological advances that better resolve earthquake structure and mechanisms in the downgoing plate (e.g., Rondenay et al., 2008; Shillington et al., 2015) and improved tomography to image the subducted slab at depths greater than the 670 km limit of earthquakes (van der Hilst et al., 1997);
- Accelerating exploration of the deep oceanic trenches because of technological advances in manned submersibles, remotely operated vehicles, and autonomous undersea vehicles (e.g., Cui et al., 2013; Okumura et al., 2016);
- Massively increased computational power allowing corresponding advances in numerical modeling of subduction zone thermal structure, metamorphism, rheology, and chemical budgets (e.g., van Keken et al., 2011; Hacker and Gerya, 2013; see Figs. 3 and 4);
- Greater understanding of connections between studies of exhumed paleo-subduction complexes (high- and ultrahigh-pressure rocks) and processes in active subduction zones, revealing intricacies between short- (seconds) and long-term (million years) deformation on plate interfaces (see Figs. 4 and 5; Angiboust et al., 2012a, 2012b), the volumetric importance of subcrustal accretionary underplating (e.g., Bassett et al., 2010) versus frontal accretion, as well as providing insights about chemical cycling in and above subduction zones (see the review by Bebout, 2014, and references therein);
- Studies of ultrahigh-pressure metamorphic rocks, coupled with thermomechanical models, demonstrating that oceanic and continental crust can be subducted to >100 km depth and returned to the surface (e.g., Gerya et al., 2002; Yamato et al., 2008);
- Improved understanding of the nature of supercritical fluids, where they exist in and above subduction zones, and their mass transport capabilities (via experimental and theoretical approaches; e.g., Manning, 2004; Hermann et al., 2006), and appreciation of the tremendous amounts of subducted water that could be stored in the mantle transition zone;
- Microanalytical advances allowing measurement of volatiles and trace element contents in minerals and melt inclusions, further constraining chemical cycling through subduction zones (Frezzotti et al., 2011) and the causes of explosive arc volcanism (e.g., Wallace, 2005; Zellmer et al., 2015);
- Improved understanding of chemical recycling via subduction of oceanic crust, sediment, and uppermost mantle (e.g., Plank, 2005), especially the cycling of volatiles at convergent margins (e.g., Hilton et al., 2002; Mason et al., 2017) and technical advances enabling field measurements of arc volcanic gas emissions (e.g., Fischer and Lopez, 2016).

Now, ~20 years after SUBCON and Big Purple, we feel it is the right time to put together another dedicated volume highlighting these major breakthroughs. In this effort, we return to the philosophy of previous ventures for an updated volume called "Subduction Top to Bottom 2," or ST2B-2 for short, that is now soliciting manuscripts. The goal of the ST2B-2 *Geosphere* special issue is to assemble a large number of papers arranged by the subduction-zone depth horizon they consider, again, independent of the methods used.

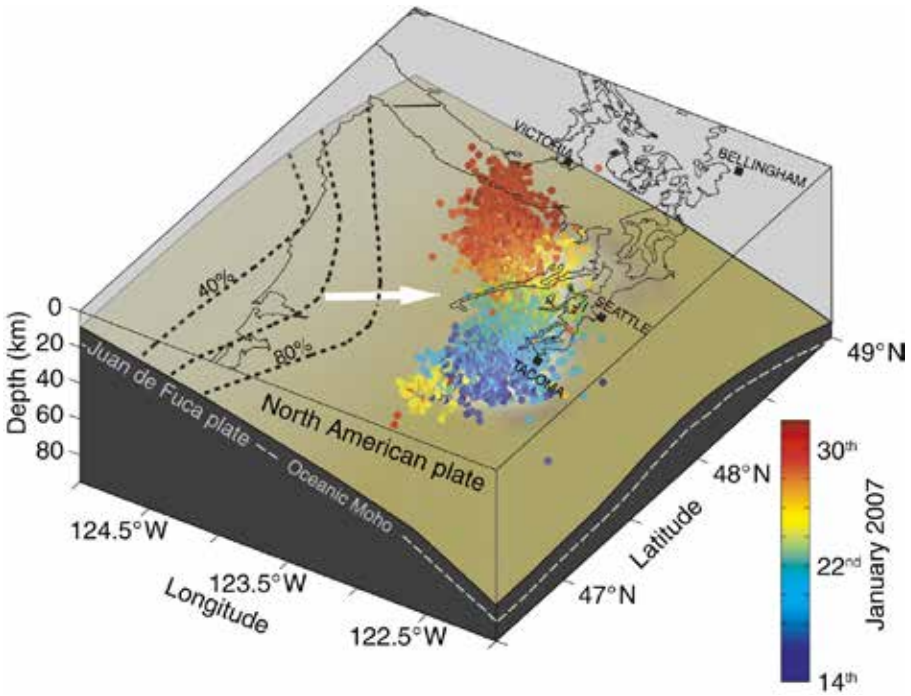

Figure 2. Illustration of northern 2007 episodic tremor and slip (ETS) event in Cascadia (from Gomberg et al., 2010). The oceanic Juan de Fuca plate subducts beneath the North America plate at ~4 cm/yr roughly perpendicular to the coast (white arrow). The plates are coupled for part of their interface (tan-colored surface) such that relative motion is inhibited or "locked" to a varying degree. Uncertain are the location and mechanism by which the locking changes to a freely slipping interface. The fraction of relative plate motion is portrayed as continuous aseismic slip that increases down-dip from 40% to 80% (dashed contours). Inland of the locked zone, tremor epicenters projected onto the plate interface (circles) overlie the area that experienced slow slip (gray area on plate interface) during the last two weeks of January 2007. Color shading of tremor epicenters shows its temporal migration.

the rheology and mechanical failure of rocks lead to greater understanding of the relationships between devolatilization and other metamorphic reactions and observed seismicity (e.g., Incel et al., 2017)? Can we decipher the balance of material delivered through an individual subduction margin by combining knowledge of inputs derived through deep-sea drilling, forearc heat flow measurements, thermal modeling, thermodynamic calculations, analysis of ancient metamorphic rocks, and analyses of volcanic gases?

THE MAKEUP OF ST2B-2

The ST2B-2 endeavor is intended to generate a large, online themed issue in the Geological Society of America journal *Geosphere*. With this online format—in our view a clear example of the future of scientific communication—we are unencumbered by page limits imposed by a physical book and by costs of color figures; furthermore, this format encourages use of interactive graphics and online data sets. Individual papers are published soon after manuscripts are accepted; there is no waiting for the slowest author(s). Published works in *Geosphere* are landscape-format and so more amenable to

We particularly encourage manuscripts employing diverse observations and methods to identify problems where differing disciplines examine similar processes. To raise awareness of the new volume, we have been holding "Subduction Top to Bottom 2" sessions (Fall 2016 AGU and 2017 GSA Annual and Fall AGU meetings).

As examples of where multidisciplinary pursuits could be particularly fruitful, forearc seismic events commonly originate along the active subduction interface or in accreted sediments experiencing pressure-temperature conditions preserved in forearc metasedimentary suites representing similar but ancient processes. Might examination of the metamorphic rock record better tell us how slow slip events and related seismic phenomena (such as tremor) happen (see Fig. 2) and, more specifically, the roles of fluids in generating such events? Could highly brecciated zones of eclogite from ancient subduction zones be the products of catastrophic energy release along the interface that generated ancient earthquakes (see Fig. 5)? Could laboratory experiments regarding

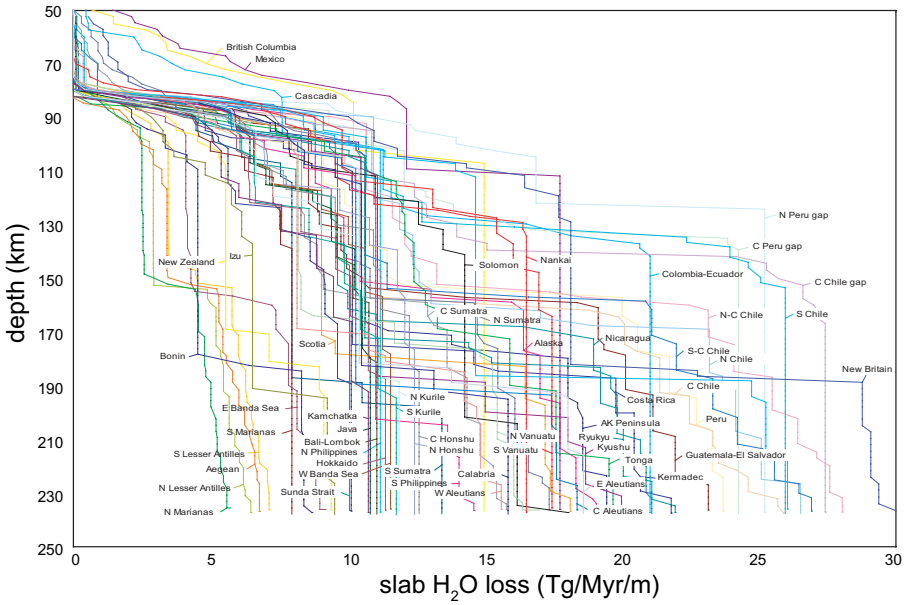

Figure 3. Diverse H_2O loss calculated as a function of depth for oceanic lithosphere and sediment subducting into each of Earth's modern subduction zones (the "Tokyo Subway Map" from van Keken et al., 2011). The warmest subduction zones lose most of their H_2O beneath the forearc. All subducting slabs lose significant water when the slab comes into contact with the hot overlying mantle wedge (in these models, at 80 km depth). For many slabs (e.g., Kamchatka, Calabria) further dehydration is minor. Other slabs (e.g., Chile) continue to dehydrate significantly with increasing depth principally due to the dehydration of the uppermost mantle. A few slabs (e.g., Marianas) are very cool, and far less H_2O is lost to even 230 km depths.

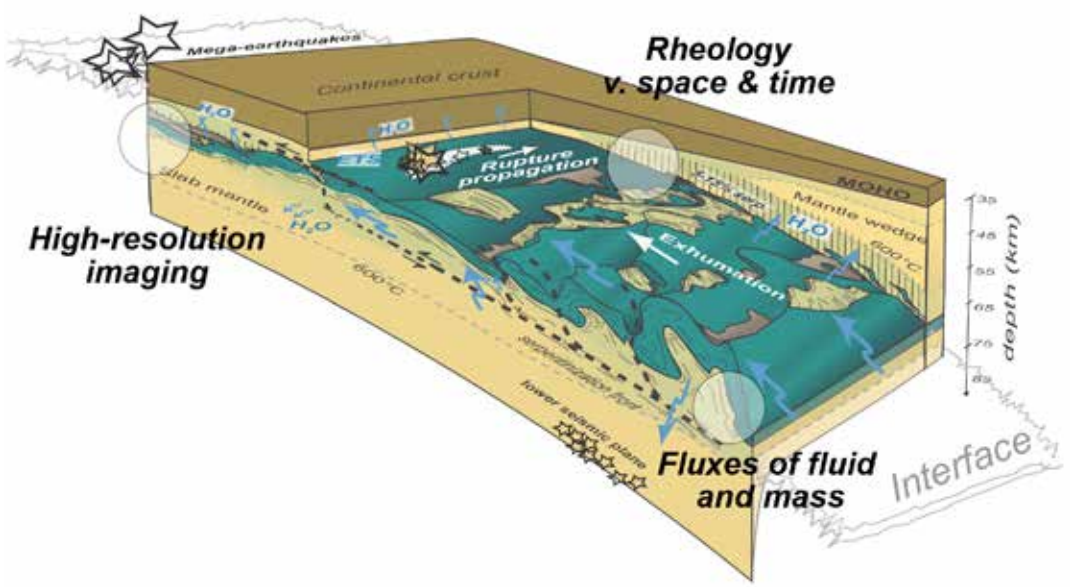

Figure 4. Schematic view of a subduction zone between 35 and 85 km depth based on numerical model results (and on study of exhumed/exposed ophiolitic terranes) showing inferred morphologies and the detachment of large folded slices of oceanic lithosphere, accreted along the plate interface (from Angiboust et al., 2012b). This figure also illustrates the main deformation-enhanced fluid pathways (associated with deep serpentinite producing/consuming reactions), dominantly at the boundary between materials with marked rheological contrasts.

viewing on a computer screen. For comparison, Big Purple faced strict manuscript length guidelines, authors did their own formatting (following the old style of AGU journals), resulting in a fairly unpolished appearance, publication of color graphics was expensive (and thus few authors published color graphics), and we had a strict time deadline in order to keep the book publication project on schedule (resulting in some authors ultimately not submitting manuscripts). In the end, Big Purple contained 39 papers, varying greatly in length, with uneven coverage of the full range of top-to-bottom subduction science.

For the all-electronic *Geosphere* themed issue, we have identified **17** subduction-zone science categories, arrayed as a function of increasing depth in a subduction zone, beginning with "What Goes In" and "Forces Driving Subduction." Each of these science categories has one to three assistant guest editors (AGEs) assigned to identifying authors invited to contribute manuscripts and be the contact individuals for those wanting to submit manuscripts. The science categories (and the associated AGEs) are as follows—at the time of acceptance of this paper, *Geosphere* ST2B-2 had amassed ~40 manuscripts in various stages of review, revision, production, and publication.

Outline of ST2B-2 *Geosphere* Themed Issue

1. Introduction;
2. What goes in (seafloor lithosphere and sediment, seamounts, and aseismic ridges). AGEs: Mike Underwood and Andy Fisher;
3. Forces driving subduction—thermal and geodynamic modeling. AGE: Taras Gerya;
4. Getting started (subduction initiation). AGE: Mark Reagan;
5. Outer rise (slab bending, deep hydration of slabs). AGEs: Doug Wiens, Cesar Ranero;
6. Shallow forearc dynamics (initial dewatering and diagenesis, fluids, accretion, erosion). AGE: Nathan Bangs;
7. Deformation of and physical conditions in the subduction interface from the seismogenic zone through the source of episodic slow slip and tremor. AGEs: Shuichi Kodaira, Sue Bilek, and Samuel Angiboust;
8. Upper plate deformation over varying timescales. AGEs: Frédérique Leclerc and Nathalie Feuillet;
9. Into the pressure cooker (metamorphism, fluid-rock interactions, records of deep underplating and exhumation, nature of deep subduction interface; also including arc delamination and drips). AGEs: Sarah Penniston-Dorland and Ake Fagereng;
10. Forearc to subarc mantle wedge. AGEs: Maureen Long and Marco Scambelluri;
11. Subduction zone magmatism (models for evolution, petrology, geochemistry, and isotopes, including batholiths). AGE: Paul Wallace;
12. Explosive volcanism hazards. AGE: Bob Tilling;
13. Geochemical and seismological expressions of deep subducted slabs. AGEs: Catherine Chauvel and Stéphane Rondenay;
14. Backarc basins, cross chains, and fold-and-thrust belts. AGEs: Fernando Martinez and Ron Hyndman;
15. Resource implications. AGEs: Gray Bebout, Bob Stern, and Dave Scholl;
16. Crust formation at convergent margins. AGEs: Kiyoshi Suyehiro and Kent Condie; and
17. Convergent margin education and outreach. AGE: Bob Stern.

The *Geosphere* ST2B-2 themed issue can be accessed at https://pubs.geoscienceworld.org/geosphere/pages/st2b2. It is open to ALL wishing to contribute to this effort. Ideally, papers in the issue will cover each of the 17 topics, and we are optimistic that more than 100 papers will ultimately be published. We anticipate that submissions for the ST2B-2 themed issue will be accepted at the least through the end of 2018, and we encourage anyone interested in contributing to contact either one of the five guest editors (one of the five of us) or the AGE(s) associated with the science category into which you envision your contribution fitting.

ACKNOWLEDGMENTS

We thank Shan de Silva, science editor of *Geosphere*, for working with us to plan and coordinate the assembly of this themed issue. Many thanks to reviewer Peter Kelemen for his constructive input, particularly in the assembly of the list of "Some Advances in Subduction Zone Science in the Past 20 Years," to the other,

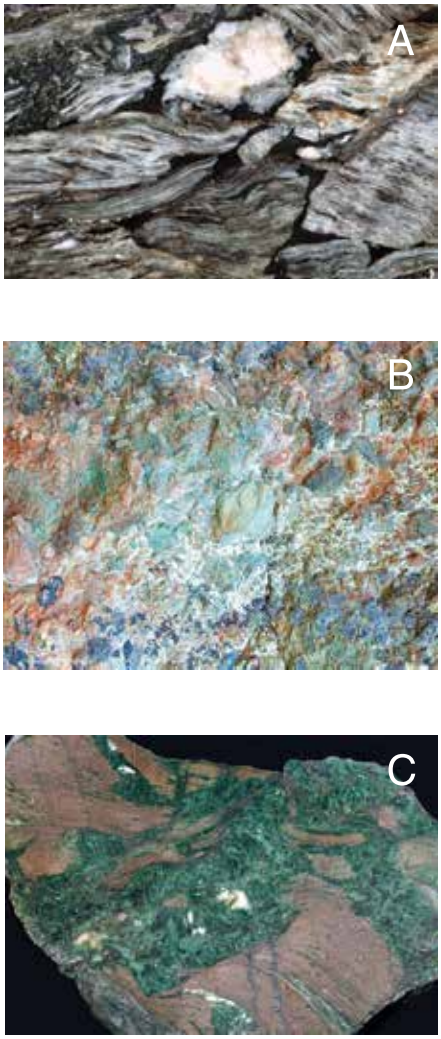

Figure 5. Examples of brecciation and fault-related melting of subduction-zone metamorphic rocks (the photographs in [A] and [C] are from Samuel Angiboust, personal commun., 2017; the photograph in [B] is from Michele Locatelli, personal commun., 2017). (A) Pseudotachylite (result of fault-related frictional heating) from the Arosa Zone St. Moritz (Switzerland) exposure of ~35 km depths of an ancient subduction zone interface investigated by Bachmann et al. (2009). The horizontal dimension is 5 cm. In this photograph, we see the result of plastic deformation (clasts are mylonitized) and evidence of melt injection during the seismic event. (B) Eclogite-facies breccia from the Monviso ultra-high pressure (UHP) metamorphic locality (Italy) representing a major rupture event at ~80 km depth in an ancient subduction zone (the horizontal dimension is ~1.0 m; see Angiboust et al., 2012a). (C) Another example of intensely fractured/brecciated eclogite-facies metabasaltic rock from the UHP metamorphic Monviso locality, showing the mineralization of these fractures by omphacite, a Na-rich pyroxene stable at extremely high pressure-temperature (*P*/*T*) conditions (the horizontal dimension is 15 cm). The mineralized matrix of the breccia in (B), and the veins in (C), reflect high-*P*/*T* element mobility, likely in H_2O-rich metamorphic fluids.

anonymous reviewer, and to Steve Whitmeyer for his efforts as *GSA Today* editor.

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Manuscript accepted 4 Oct. 2017

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GSA Division Awards

Give recognition where it is due—nominate a deserving colleague today!
For award descriptions and nomination details, see the January 2018 issue of *GSA Today*, or go to **www.geosociety.org/divisions.**

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Career Contribution Award
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Nominations due 12 Aug.

CALL FOR NOMINATIONS

International Awards

GSA James B. Thompson Jr. Distinguished International Lectureships

GSA International seeks nominations for distinguished geoscientist speakers for the 2018–2019 GSA James B. Thompson Jr. Distinguished International Lectureship. Nominations are being accepted for two dynamic speakers of established scientific stature who can present stimulating and cutting-edge geoscience research for one or two tours each. The nominees may be either living outside of North America and be able to lecture at North American institutions, or be living within North America and be able to lecture outside of North America on topics that are at the forefront of research in order to raise visibility for The Geological Society of America within the international geoscience community. The deadline to submit your nominations is 1 March 2018 (self-nominations are welcome): **www.geosociety.org/Intl-LectureTour.**

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The National Association of Geoscience Teachers (NAGT)

Tectonosedimentary Relations of Pennsylvanian to Jurassic Strata on the Colorado Plateau

by William R. Dickinson

William R. Dickinson (1931–2015) formally retired in 1991, but he didn't stop working, researching, and writing. His work with University of Arizona professor George Gehrels on identifying sandstone provenance using detrital-zircon U-Pb geochronology led to the determination that much of the Pennsylvanian to Jurassic sandstone of the Colorado Plateau was derived from the orogenic belt now associated with the Appalachian Mountains. Further detrital-zircon studies led to Dickinson preparing this publication in order to identify key aspects of the sedimentary and tectonic history of Mesozoic strata of the Colorado Plateau and directly adjacent areas. Dickinson divided the strata into seven depositional systems, but completed writing on only the lower five (Moenkopi, Chinle, Glen Canyon, San Rafael, Morrison) before his death in July 2015. The manuscript, however, was comprehensive in its treatment of upper Paleozoic strata and the lower five Mesozoic "deposystems," and an abstract and concluding text by Jon Spencer helped to complete the work.

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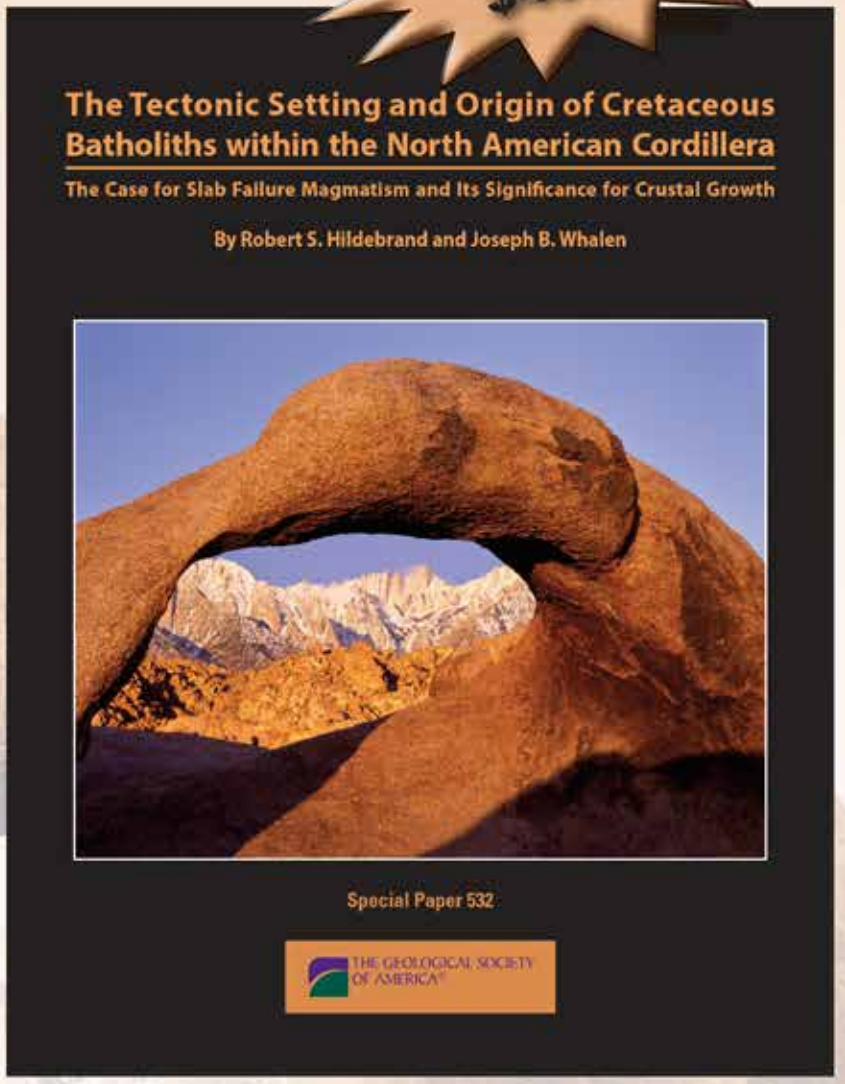

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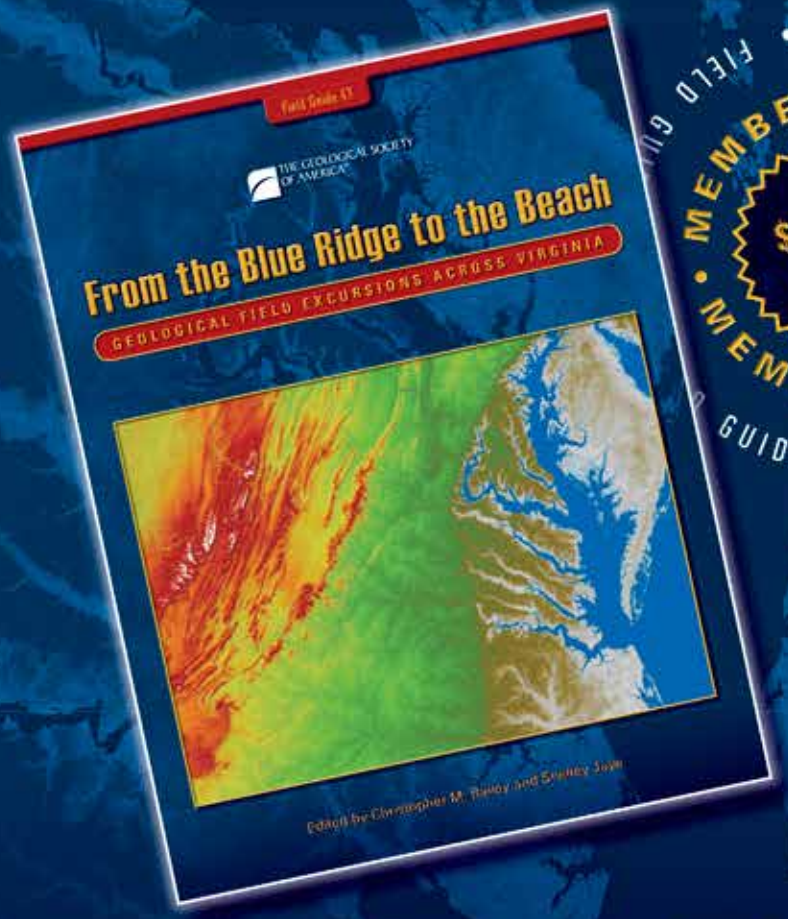

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Second Announcement and Call for Papers

JOINT MEETING

70th Annual Meeting of the Rocky Mountain Section, GSA
114th Annual Meeting of the Cordilleran Section, GSA
Flagstaff, Arizona, USA
15–17 May 2018

www.geosociety.org/rm-mtg/

Sunset Crater is a cinder cone located north of Flagstaff, Arizona, USA.

LOCATION

Flagstaff lies at 7000 feet (~2100 m) elevation on the southern edge of the geologically world-class Colorado Plateau, near the southern margin of the young and active San Francisco volcanic field. The city is located just north of the Transition Zone and Basin-and-Range provinces, including the tourist destination of Sedona, one hour away. The Grand Canyon is a 1.5-hour drive north of Flagstaff, and numerous geologically significant national parks and monuments are scattered across the region. We have devised a diverse technical program and field trips that explore the geology of the Southwest and span from modern to ancient processes, and from environmental problems to tectonics, geophysics, paleontology, climate, education, and more. We include sessions on planetary geology and Southwest rivers that build on the strong legacy and current expertise of the local U.S. Geological Survey. Flagstaff is home to Northern Arizona University (NAU) and its School of Earth Sciences and Environmental Sustainability. We are holding the meeting in mid-May immediately after the NAU school year, while the weather is good on the plateau and in the Transition Zone.

REGISTRATION

Early registration deadline: 9 April
Cancellation deadline: 16 April

Registration opens in early February. For further information, or if you need special accommodations, please contact one of the conference chairs, Paul Umhoefer, paul.umhoefer@nau.edu, or Dennis Newell, dennis.newell@usu.edu.

Registration fees (all fees are in U.S. dollars)

	Early		Standard	
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ACCOMMODATIONS

Hotel reservation deadline: 26 April

A block of rooms has been reserved at the DoubleTree by Hilton at 1175 West Route 66, Flagstaff, Arizona 86001, USA, the site of the meeting. The meeting rate is US$159 per night plus tax for single and double occupancy, US$143 for the government rate. Reservations should be made by calling the DoubleTree directly at +1-928-773-8888 (local). Attendees should reference the group code of "Geological Society of America."

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TECHNICAL SESSIONS

Symposia

S1. **Tectonics of the Death Valley Region: A Tribute to Bennie Troxel and Lauren Wright.** *Cosponsored by GSA Geophysics Division; GSA Structural Geology and Tectonics Division.* Terry Pavlis, Univ. of Texas–El Paso, tlpavlis@utep.edu; Laura Serpa, Univ. of Texas–El Paso, lfserpa@utep.edu; James Calzia, USGS, jcalzia@usgs.gov; Darrel Cowan, Univ. of Washington, darrel@u.washington.edu; Marli Miller, Univ. of Oregon, millerm@uoregon.edu.

S2. **Cordilleran Tectonics, Metamorphic Core Complexes, Geologic Mapping, and Arizona Geology: A Celebration of Jon Spencer's Career.** *Cosponsored by GSA Structural Geology and Tectonics Division.* John Singleton, Colorado State University, john.singleton@colostate.edu; Stephen Reynolds, Arizona State Univ., sreynolds@asu.edu; Kurt Constenius, Univ. of Arizona, kconstenius@comcast.net.

S3. **Recent Advances in Basin-and-Range and Proterozoic Geology of the Western U.S.: A Session Honoring Ernie Duebendorfer.** *Cosponsored by GSA Structural Geology and Tectonics Division.* Chloe Bonamici, New Mexico Tech, chloe.bonamici@nmt.edu; Kevin Chamberlin, Univ. of Wyoming, kchamber@uwyo.edu; Mike Williams, Univ. of Massachusetts, mlw@geo.umass.edu.

S4. **Jurassic to Cenozoic Geology of Southern California, Southwest Arizona, and Sonora: A Session Honoring Gordon Haxel and Carl Jacobson.** *Cosponsored by GSA Structural Geology and Tectonics Division.* Jon Spencer, Univ. of Arizona, spencer7@email.arizona.edu; Sue Beard, USGS, sbeard@usgs.gov.

Theme Sessions

T1. **Miocene to Recent Evolution of the Lower Colorado River Corridor and the Northern Gulf of California.** *Cosponsored by GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division.* Ryan Crow, USGS, rcrow@usgs.gov; Kris McDougall, USGS, kris@usgs.gov; Scott Bennett, USGS, sekbennett@usgs.gov; Mike Darin, Northern Arizona Univ., michael.darin@nau.edu.

T2. **Earth Surface Processes in the Critical Zone.** *Cosponsored by GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division.* Tim White, Penn State Univ., tsw113@psu.edu; Jon Pelletier, Univ. of Arizona, jon@geo.arizona.edu.

T3. **Advances in River Science in the Intermountain West.** *Cosponsored by GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division.* Erich Mueller, University of Wyoming, erich.mueller@uwyo.edu.; Paul Grams, USGS, pgrams@usgs.gov; Daniel Buscombe, Northern Arizona Univ., Daniel.Buscombe@nau.edu; Dave Dean, USGS, djdean@usgs.gov.

T4. **New Insights into the Development and Evolution of the Colorado River System from Geologic Mapping (Posters).** *Cosponsored by GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division.* Kyle House, USGS, khouse@usgs.gov; Phil Pearthree, Arizona Geological Survey, pearthre@email.arizona.edu.

T5. **Post-Wildfire Hazards: From New Research to Assessments, Prediction, and Mitigation.** *Cosponsored by GSA Quaternary Geology and Geomorphology Division; GSA Hydrogeology Division.* Ann Youberg, Arizona Geological Survey, ayouberg@amail.arizona.edu; Luke McGuire, Univ. of Arizona, lmcguire@email.arizona.edu.

T6. **Colorado Plateau Landscape Evolution—Grand Canyon–and Upper Basin–Focused Colorado River Evolution.** *Cosponsored by GSA Geophysics Division; GSA Structural Geology and Tectonics Division; GSA Quaternary Geology and Geomorphology Division.* Sue Beard, USGS, sbeard@usgs.gov; Andres Aslan, Colorado Mesa University, aaslan@coloradomesa.edu; Richard Young, SUNY Geneseo, young@geneseo.edu; Karl Karlstrom, Univ. of New Mexico, kek1@unm.edu.

T7. **Seismic and Geophysical Perspectives: New Insights into the Structure of the Shallow Crust of the Rocky Mountains and Cordillera.** *Cosponsored by GSA Geophysics Division; GSA Structural Geology and Tectonics Division.* Joshua Coyan, USGS, jcoyan@usgs.gov; Geoff Phelps, USGS, gphelps@usgs.gov.

T8. **Laramide Tectonics in the Southwest North American Cordilleran Interior.** *Cosponsored by GSA Geophysics Division; GSA Structural Geology and Tectonics Division.* Jay Chapman, Univ. of Arizona, jaychapman@email.arizona.edu; Ryan Porter, Northern Arizona Univ., ryan.porter@nau.edu; Chris Clinkscales, Univ. of Arizona, clinkscales@email.arizona.edu.

T9. **Cenozoic Extension in Western North America.** *Cosponsored by GSA Geophysics Division; GSA Structural Geology and Tectonics Division.* Lisa Lamb, St. Thomas Univ., malamb@stthomas.edu; John Singleton, Colorado State Univ., John.Singleton@colostate.edu; Gary Axen, New Mexico Tech, gary.axen@nmt.edu; Jolante Van Wijk, New Mexico Tech, jolante.vanwijk@nmt.edu; Jason Ricketts, Univ. of Texas–El Paso, jricketts@utep.edu.

T10. **Geologic and Structural Evolution of the Transition Zone.** *Cosponsored by GSA Geophysics Division; GSA Quaternary Geology and Geomorphology Division; GSA Structural Geology and Tectonics Division.* Alan Chapman, Macalester College, chapman@macalester.edu; Nancy Riggs, Northern Arizona Univ., Nancy.Riggs@nau.edu; Tim Schroeder, Bennington College, tschroeder@bennington.edu; Jessie Shields, California State Univ.–Fresno, jessieshields9@mail.fresnostate.edu.

T11. **Pennsylvanian to Early Triassic Tectonics of Southwest Laurentia.** *Cosponsored by GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Sedimentary Geology Division; GSA Structural Geology and Tectonics Division.* Nancy Riggs, Northern Arizona Univ., nancy.riggs@nau.edu; Andy Barth, Indiana Univ., ibsz100@iupui.edu; Robinson Cecil, California State Univ.–Northridge, Robinson.Cecil@csun.edu.

T12. **Plate Margin Processes and Tectonics during the Cretaceous, Western North America.** *Cosponsored by GSA Geophysics Division; GSA Structural Geology and Tectonics Division.* Bernie Housen, Western Washington Univ., Bernard.Housen@wwu.edu; Basil Tikoff, Univ. of Wisconsin, basil@geology.wisc.edu.

T13. **Emerging Ideas on the Ancestral Rocky Mountain System.** *Cosponsored by GSA Structural Geology and Tectonics Division.* Ryan Leary, Northern Arizona Univ., ryan.leary@nau.edu; Paul Umhoefer, Northern Arizona Univ., paul.umhoefer@nau.edu; Mike Smith, Northern Arizona Univ., michael.e.smith@nau.edu.

T14. **Paleomagnetic, Structural, and Geophysical Data Applied to Intrusive and Extrusive Igneous Systems, Tectonic Applications, and Paleoclimate Studies.** *Cosponsored by GSA Geophysics Division; GSA Structural Geology and Tectonics Division.* Michael S. Petronis, New Mexico Highlands Univ., mspetro@nmhu.edu; Filip Tomek, Czech Academy of Sciences, filip.tomek@gmail.com;

Jennifer Lindline, New Mexico Highlands Univ., lindlinej@nmhu.edu.

T15. **Genetic Links between the Magmatism, Tectonism, and Metallogeny of the Southwestern USA and Northern Mexico.** Simon Jowitt, Univ. of Nevada–Las Vegas, simon.jowitt@unlv.edu; Graham Andrews, West Virginia Univ., gda0005@mail.wvu.edu.

T16. **Understanding Water Resources Related to Mineralized Uranium Deposits in the Southwestern United States.** *Cosponsored by GSA Energy Geology Division; GSA Hydrogeology Division.* Johanna Blake, USGS, jmtblake@usgs.gov; Kim Beisner, USGS, kbeisner@usgs.gov; Jose Cerrato, Univ. of New Mexico, jcerrato@unm.edu; Andrew Robertson, USGS, ajrobert@usgs.gov.

T17. **Chemical and Isotopic Tracers of Water Sources in Semiarid Regions: From the Mantle to the Atmosphere.** *Cosponsored by GSA Energy Geology Division; GSA Hydrogeology Division.* Kimberly Samuels-Crow, Northern Arizona Univ., Kimberly.Samuels@nau.edu; Laura Crossey, Univ. of New Mexico, lcrossey@unm.edu; Abe Springer, Northern Arizona Univ., abe.springer@nau.edu.

T18. **Paleoclimate Records and Future Climate Trends in the American Southwest.** *Cosponsored by GSA Quaternary Geology and Geomorphology Division.* Tammy Rittenour, Utah State Univ., tammy.rittenour@usu.edu; Andrea Brunelle, Univ. of Utah, andrea.brunelle@geog.utah.edu.

T19. **Paleontology of the Colorado Plateau and Environs.** Dave Elliott, Northern Arizona Univ., david.elliott@nau.edu; Bill Parker, Petrified Forest National Park, william_parker@nps.gov.

T20. **Biostratigraphy and Paleoenvironments of Western North America: Correlations across the International Border.** Pilar Navas-Parejo, UNAM–Hermosillo, petalo@gmail.com.

T21. **Recent Advances in Planetary Geoscience.** *Cosponsored by GSA Geophysics Division.* Nadine Barlow, Northern Arizona Univ., nadine.barlow@nau.edu; Jim Skinner, USGS, jskinner@usgs.gov; Mark Salvatore, USGS, mark.salvatore@nau.edu.

T22. **Earth as a Stepping Stone for Planetary Exploration.** *Cosponsored by GSA Geophysics Division.* Lauren Edgar, USGS, ledgar@usgs.gov; Christopher Edwards, Northern Arizona Univ., christopher.edwards@nau.edu; Jim Skinner, USGS, jskinner@usgs.gov; Kelsey Young, NASA, kelsey.e.young@nasa.gov.

T23. **Integrating Composition and Morphology: Keys to Constraining Planetary Surface Processes from Spacecraft Data.** *Cosponsored by GSA Quaternary Geology and Geomorphology Division.* Kristen Bennett, Northern Arizona Univ., kristen.bennett@nau.edu; Christopher Edwards, Northern Arizona Univ., christopher.edwards@nau.edu; Nadine Barlow, Northern Arizona Univ., nadine.barlow@nau.edu; Will Grundy, Lowell Observatory, grundy@lowell.edu.

T24. **Understanding Basin Environments and Evolution Beyond Earth.** *Cosponsored by GSA Geophysics Division.* Jim Skinner, USGS, jskinner@usgs.gov; Lauren Edgar, USGS, ledgar@usgs.gov, Kristen Bennett, Northern Arizona Univ., kristen.bennett@nau.edu; Chris Okubo, USGS, cokubo@usgs.gov.

T25. **Geologic Applications of Unmanned Aerial Systems.** *Cosponsored by GSA Geophysics Division; GSA Quaternary Geology and Geomorphology Division.* Art Sylvester, Univ. of California Santa Barbara, sylvester@ucsb.edu; Ramon Arrowsmith, Arizona State Univ., ramon.arrowsmith@asu.edu; Nicholas Barth, Univ. of California Riverside, nic.barth@ucr.edu; Chris Crosby, UNAVCO, crosby@unavco.org.

T26. **Recent Advances in Understanding the Geology of Northwestern Mexico.** *Cosponsored by GSA Geophysics Division; GSA Structual Geology and Tectonics Division.* Carlos Gonzalez-Leon, UNAM–Hermosillo, cmgleon@unam.mx; Luca Ferarri, UNAM–Mexico City, luca@unam.mx.

T27. **Geoscience and Environmental Science Education in the Cordillera and Rockies: Research and Practice (Posters).** *Cosponsored by GSA Geophysics Division; GSA Geoscience Education Division*. Steven Semken, Arizona State Univ., semken@asu.edu; Callan Bentley, Northern Virginia Community College, cbentley@nvcc.edu.

T28. **The Happy Marriage of Geology and Art (Posters).** *Cosponsored by GSA Geophysics Division; GSA Mineralogy, Geochemistry, Petrology, and Volcanology Division; GSA Geology and Society Division; GSA History and Philosophy of Geology Division.* Steven Emmerman, Utah Valley Univ., stevene@uvu.edu; Lori Santos, Wichita State, lorisantosarted@gmail.com.

T29. **Undergraduate Research Session (Posters).** *Cosponsored by GSA Energy Geology Division; GSA Structural Geology and Tectonics Division; Council on Undergraduate Research*; *National Association of Geoscience Teachers.* Jeff Marshall, Cal Poly Pomona, marshall@cpp.edu.

FIELD TRIPS

For additional information, please contact the field trip chairs, Michael Smith, michael.e.smith@nau.edu, and Steve Semken, semken@asu.edu. All trips depart from the DoubleTree by Hilton unless otherwise noted.

Pre-Meeting

1. **Silver Creek Caldera and Peach Spring Tuff.** Sun.–Mon., 13–14 May, 7:30 a.m. departure; 4:30 p.m. return. Cost: US$268 (includes transportation, guidebook, one night lodging, lunch, and snacks). Organizer: Charles Ferguson, Arizona Geological Survey, caf@email.arizona.edu.
2. **Informal Geoscience Education on the Trail of Time at Grand Canyon National Park.** Mon., 14 May, 7:30 a.m. departure; 4:30 p.m. return. Cost: US$90 (includes transportation, park entrance fee, snacks; does not include lunch at Grand Canyon Village). Organizers: Steven Semken, Arizona State Univ., semken@asu.edu; Karl Karlstrom, Univ. of New Mexico, kek1@unm.edu; Laura Crossey, Univ. of New Mexico, lcrossey@unm.edu; Ryan Crow, USGS Flagstaff, rcrow@usgs.gov.

Post-Meeting

3. **Oligocene Incision of Grand Canyon, Grandview Trail to Horseshoe Mesa.** Fri., 18 May, 7:30 a.m. departure; 4:30 p.m. return. Cost: US$100 (includes transportation, snacks). Organizer: Jim Sears, Univ. of Montana, james.sears@mso.umt.edu.
4. **Tectonic and Magmatic Evolution of the Snake Range Metamorphic Core Complex, East Central Nevada.** Fri.–Sun., 18–21 May, 7:30 a.m. departure from Las Vegas; return to the Las Vegas airport 5 p.m., with optional transport from Flagstaff to Las Vegas on the evening of 17 May. Cost: US$490 (includes transportation, four nights' lodging, breakfast, lunch, snacks, and field guide). Organizer: Phillip Gans, Univ. of California Santa Barbara, gans@geol.ucsb.edu.

SHORT COURSES

MON., 14 MAY

Morning

1. **Digital Geology Teaching Tools.** Cost: US$10. Callan Bentley, Northern Virginia Community College, cbentley@nvcc.edu; Steve Whitmeyer, James Madison Univ., whitmesj@jmu.edu. Room 223, Friar Hall, NAU.
2. **Prospective UAV Users for Geologic Purposes.** Cost: US$10. Arthur G. Sylvester, Univ. of California Santa Barbara, sylvester@geol.ucsb.edu. Room 109, Friar Hall, NAU.

Afternoon

3. **Digital Field Methods for Sed/Strat and Structural Geology: Use of Tablet-Based Apps for Mapping and Measurements in Undergraduate Courses.** Cost: US$10. Lawrence Malinconico, Lafayette College, malincol@lafayette.edu; Lisa Skinner, Northern Arizona University, lisa.skinner@nau.edu. Room 223, Friar Hall, NAU.
4. **UAV Geologic Applications.** Cost: US$10. Arthur G. Sylvester, Univ. of California, Santa Barbara, sylvester@geol.ucsb.edu. Room 109, Friar Hall, NAU.

Full Day

5. **Assessing Contaminant Sources and Aquifer Continuity in Soil/Groundwater Using Stable Isotopes of Strontium (Sr) and Lead (Pb).** Cost: US$20. Richard W. Hurst, California Lutheran Univ., rhurst@callutheran.edu. Room 111, Friar Hall, NAU.

FRI., MAY 18

Full Day

6. **Collecting Geological Field Data Using the StraboSpot Data System.** Cost: US$20. Doug Walker, Univ. of Kansas, jdwalker@ku.edu; Emily Bunse, Univ. of Kansas; Basil Tikoff, Univ. of Wisconsin–Madison, basil@geology.wisc.edu. Room 109, Friar Hall, NAU.

MENTOR PROGRAMS

For more information, visit the GSA mentors page or contact Jennifer Nocerino, jnocerino@geosociety.org.

Roy J. Shlemon Mentor Program in Applied Geosciences
Tues., 15 May, noon–1:30 p.m.

This program is designed to extend the mentoring reach of individual professionals from applied geology to undergraduate and graduate students. Students and mentors: Join us for a free lunch. Space is limited—first come, first served.

Mann Mentors in Applied Hydrogeology Program
Wed., 16 May, noon–1:30 p.m.

This program presents mentoring opportunities for undergraduate, graduate, and recently graduated students with a declared interest in applied hydrogeology as a career. Lunch will be provided for students and mentors. Space is limited—first come, first served.

GEOSCIENCE CAREER WORKSHOPS

Part 1: Career Planning and Informational Interviewing. *Your job-hunting process should begin with career planning, not when you apply for jobs.* This workshop will help you begin this process and will introduce you to informational interviewing. Tues., 15 May, 9–10 a.m.

Part 2: Geoscience Career Exploration. *What do geologists in various sectors earn? What do they do?* What are the pros and cons to working in academia, government, and industry? Workshop presenters and professionals in the field will address these issues. Tues., 15 May, 10–11 a.m.

Part 3: Cover Letters, Résumés, and CVs. *How do you prepare a cover letter? Does your résumé need a good edit?* Whether you are currently in the market for a job or not, learn how to prepare the best résumé possible. You will review numerous examples to help you learn important résumé dos and don'ts. Wed., 16 May, 9–10 a.m.

ORGANIZING COMMITTEE

Meeting General Chair: Paul Umhoefer, Northern Arizona University (NAU), paul.umhoefer@nau.edu

Rocky Mountain Co-Chair: Dennis Newell, Utah State, dennis.newell@usu.edu

Technical Program Chairs: Nancy Riggs, NAU, nancy.riggs@nau.edu; Ryan Crow, USGS, rcrow@usgs.gov; Dave Elliott, NAU, david.elliott@nau.edu

Field Trip Chairs: Mike Smith, NAU, michael.e.smith@nau.edu; Steve Semken, Arizona State University (ASU), semken@asu.edu

Exhibits & Sponsorships: Stephen Reynolds, ASU, sreynolds@asu.edu

Short Courses: Lisa A. Skinner, NAU, lisa.skinner@nau.edu

Student Volunteers: Lisa A. Skinner, NAU, lisa.skinner@nau.edu

New RM/CD Section Meeting Mentoring Program

GSA is piloting a meeting mentorship program and seeks mentors (professionals and early career professionals) and students to participate in this program. Pairs are required to meet in-person for 30 minutes for each day. Sign up on your registration form.

To learn more check the section meeting website or email Tahlia Bear at tbear@geosociety.org.

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ELECTIONS: GSA OFFICERS and COUNCILORS

GSA ELECTIONS BEGIN 15 MARCH 2018

GSA's success depends on you—its members—and the work of the officers serving on GSA's Executive Committee and Council. Members will receive instructions for accessing a member-only electronic ballot via our secure website, and biographical information on the nominees will be online for you to review at that time. Paper versions of both the ballot and candidate information will also be available upon request. Please help continue to shape GSA's future by voting on these nominees.

2018 OFFICER NOMINEES

PRESIDENT
(July 2018–June 2019)
Robbie R. Gries
Gries Energy Partners LLC
Lakewood, Colorado, USA
We congratulate our incoming president!

PRESIDENT-ELECT/PRESIDENT
(July 2018–June 2019)/
(July 2019–June 2020)
Donald Siegel
Syracuse University
Syracuse, New York, USA

TREASURER
(July 2018–June 2019)
Richard C. Berg
Illinois State Geological Survey
Champaign, Illinois, USA

2018 COUNCIL NOMINEES

COUNCILOR POSITION 1
(July 2018–June 2022)
Jeffrey Rubin
Tualatin Valley Fire & Rescue
Tigard, Oregon, USA

David Spears
Division of Geology and Mineral Resources
Charlottesville, Virginia, USA

COUNCILOR POSITION 2
(July 2018–June 2022)
Rodney Metcalf
University of Nevada–Las Vegas
Las Vegas, Nevada, USA

Nathan Niemi
University of Michigan
Ann Arbor, Michigan, USA

COUNCILOR POSITION 3
Sections Liaison
(July 2018–June 2022)
Wendy Bohrson
Central Washington University
Ellensburg, Washington, USA

Jon Mies
University of Tennessee
Chattanooga, Tennessee, USA

To be counted, ballots must be submitted electronically, faxed to GSA Headquarters, or postmarked before midnight on **14 April 2018.**

GSA Committee Vacancies Available for Nominations by 15 June 2018

Terms begin 1 July 2019 unless otherwise noted. View open positions and access the nomination form at **www.geosociety.org/nominate.** GSA Headquarters Contact: Dominique Olvera, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA; fax: +1-303-357-1060; dolvera@geosociety.org.

B—Meets in Boulder or elsewhere; **E**—Communicates by phone or electronically;
M—Meets at the Annual Meeting; **T**—Extensive time commitment required during application review period.

COMMITTEE NAME	NUMBER OF VACANCIES	POSITION TITLE / SPECIAL REQUIREMENTS	TERM (years)
Annual Program Committee (B/E/M)	3	• Members-at-Large • Member-at-Large Student	4 2
Arthur L. Day Medal Award (E/T)	2	• Members-at-Large	3
Diversity in the Geosciences (E/M)	2	• Members-at-Large	3
Education (B/E/M)	3	• Member-at-Large • Graduate Student Representative • 4-Year College Faculty	4 2 4
Geologic Mapping Award (E)	2	• Member-at-Large • Member-at-Large Student	3 3
Geology and Public Policy (B/E/M)	1	• Member-at-Large	3
GSA International (E/M)	4	• Member-at-Large • Secretary • IIG, Chair • Chair	4 4 4 4
Joint Technical Program (E) Terms begin December 2018	2	• Member-at-Large • Member-at-Large (Marine/Coastal Geology)	2 2
Membership and Fellowship (B/T)	2	• Members-at-Large Academia	3
Nominations (B/E)	2	• Members-at-Large	3
Penrose Conferences and Field Forums (E)	2	• Members-at-Large (Convener of a past Penrose Conference or Field Forum)	3
Penrose Medal Award (E/T)	2	• Members-at-Large	3
Professional Development (E)	2	• Former Councilor • Member-at-Large Student	3
Publications Committee (B/E/M)	1	• Member-at-Large	4
Research Grants (B/T)	9	• Members-at-Large (intensive time commitment in February–March each year)	3
Young Scientist Award (Donath Medal) (E/T)	2	• Member-at-Large • Member-at-Large (Councilor, former Councilor)	3 3

Geoscience Jobs & Opportunities

Ads (or cancellations) must reach the GSA advertising office no later than the first of the month, one month prior to the issue in which they are to be published. Contact advertising@geosociety.org, +1.800.472.1988 ext. 1053, or +1.303.357.1053. All correspondence must include complete contact information, including e-mail and mailing addresses.
Rates are in U.S. dollars.

Classification	Per Line for 1st month	Per line each addt'l month (same ad)
Positions Open	$9.30	$9.25
Fellowship Opportunities	$9.30	$9.25
Opportunities for Students		
First 25 lines	$0.00	$5.00
Additional lines	$5.00	$5.00

Positions Open

ENDOWED CHAIR
IN STRUCTURAL GEOLOGY
JACKSON SCHOOL OF GEOSCIENCES
UNIVERSITY OF TEXAS AT AUSTIN

The Department of Geological Sciences in the Jackson School of Geosciences at the University of Texas at Austin is looking for an Endowed Chair in Structural Geology to take up a tenured position at the full professor level.

We seek a creative individual with a vigorous science program who uses constraints from the field to enhance our understanding of the processes that shape the planet. We take a broad view of the often inter- and cross-disciplinary research addressed by structural geology but an ability to extract constraints on the ground, teach structural geology, and mentor field-based students is required.

We also put emphasis on synergy and collegiality and seek an individual who complements the range of research efforts at the department and the Jackson School, and whose interests are aligned with departmental strengths such as in lithospheric dynamics.

The appointee is expected to establish a world-class research program and fulfill regular teaching, mentoring, and service roles at the department and should have a proven record of obtaining external research funding. The department is interested in building a culturally diverse intellectual community; we strongly encourage applications from all underrepresented groups.

As part of the Jackson School of Geosciences, the Department of Geological Sciences has ~50 faculty and a community of ~90 research scientists in the Institute for Geophysics and Bureau of Economic Geology, with a broad range of specialties, as well as access to outstanding research facilities and support.

Applicants should submit a letter of application, curriculum vitae, 2-page statements of research and teaching interests, and contact information for five references. Submit electronic copies of these materials online at apply.interfolio.com/47139. For questions related to the search, please contact dgs@jsg.utexas.edu. Review of applications will begin immediately and continue until the position is filled.

ELECTRON MICROPROBE
OPERATOR/LABORATORY MANAGER
UNIVERSITY OF OKLAHOMA

The Office of the Vice President of Research supports an electron microanalysis laboratory built around a Cameca SX100 microprobe as a core research facility of the University (https://ors.ou.edu/Microprobe/OUEMPLHome.html). This includes a fully funded, twelve-month annual staff position as Electron Microprobe Operator/Laboratory Manager. The staff appointment level is Research Scientist II with a starting salary of $55K-$60K. This position is open until filled.

Duties include daily operation of the microprobe and sample preparation for all clients, daily lab maintenance, periodic instrument maintenance (filament, roughing vacuum, etc.), coordinating major service with Cameca engineers, scheduling and bookkeeping of usage by clients, billing and payments, and an annual summary report of laboratory activity. The appointment permits the operator to utilize the electron microprobe for research and personal use. Adjunct professor status and teaching opportunities in the School of Geology & Geophysics are possible for individuals who hold a Ph.D.

Qualifications for the position include (1) a Master's or Ph.D. degree in geosciences or a relevant discipline, (2) experience with designing analytical procedures for quantitative EMPA, (3) knowledge of the chemistry of major and minor elements in the common rock-forming minerals, and (4) experience with EMP operation including basic maintenance. Applicants must submit (1) a cover letter that includes career goals and prior experience in electron microprobe analysis, (2) a CV that includes employment history and responsibilities, (3) transcripts of baccalaureate and master's degree courses, and (4) two letters of recommendation from individuals who are qualified to comment on the suitability of the applicant for the position. Letters should be sent by the recommenders directly to Salina Wall (salinawall@ou.edu) with the subject line "EMPL operator letter".

In 2014, OU became the first public institution ever to rank #1 nationally in the recruitment of National Merit Scholars. The 277-acre Research Campus in Norman was named the No.1 research campus in the nation by the Association of Research Parks in 2013. Norman is a culturally rich and vibrant town located just outside Oklahoma City. With outstanding schools, amenities, and a low cost of living, Norman is a perennial contender on the "Best Places to Live" rankings. Visit soonerway.ou.edu for more information.

Applicants must submit an ONLINE application at https://jobs.ou.edu for job requisition number 173902. Computers and personal assistance are available at the Office of Human Resources, 905 Asp, Rm.205, Norman, OK 73069.

The University of Oklahoma is an Affirmative Action, Equal Opportunity Employer. Women and minorities are encouraged to apply. Protected veterans and individuals with disabilities who meet the requirements of the position are encouraged to apply.

HEAD AND PROFESSOR
DEPT. OF EARTH, ATMOSPHERIC,
AND PLANETARY SCIENCES
PURDUE UNIVERSITY

Purdue University invites applications for the position of Head of the Department of Earth, Atmospheric, and Planetary Sciences to start as early as August 2018. We seek a recognized researcher with a proven track record of leadership, vision, and mentoring. The successful candidate will have a clear plan to continue to increase the visibility, stature, and intellectual leadership of the department and the College of Science. The department head will demonstrate a commitment to excellence in teaching. The EAPS department is an interdisciplinary department with 40 faculty whose diverse research topics range from the Earth's mantle through the atmosphere, to the surfaces of other planets, to sustainable communities. We currently have new research initiatives in energy and environment, natural disasters and hazards, and data science. Department faculty are also involved in University-wide multidisciplinary research in planetary science, geochronology, climate change, and environmental science. Further information about the Department can be found at https://www.eaps.purdue.edu/ and additional materials are available upon request.

The Department of Earth, Atmospheric, and Planetary Sciences is one of seven departments in the College of Science with involvement in numerous interdisciplinary programs and centers. Beyond the College, Purdue's strengths in Engineering, Agriculture, Veterinary Medicine, Pharmacy and the Health and Human Sciences

contribute to a robust research and educational environment. Further information on the College of Science is available on the website at www.science.purdue.edu.

Qualifications: The successful candidate will have a Ph.D. in Earth, Atmospheric, and Planetary Sciences or a related discipline, an outstanding record of scholarly achievement and a history of extramurally funded research commensurate with the rank of full professor at Purdue, exceptional and proven leadership abilities, a vision for the Department in the university, state, and nation, a commitment to excellence in undergraduate and graduate education, an enthusiasm for engagement, and a dedication to championing diversity and inclusion.

Applications: Interested candidates should submit a cover letter, curriculum vitae with the names and e-mail addresses of three references, a statement of research and teaching accomplishments, and a vision statement for the future of EAPS research and education. Applications should be submitted to http://hiring.science.purdue.edu. Inquiries should be directed to Ken Ridgway, Chair of EAPS Head Search Committee, ridge@purdue.edu. Review of applications will begin February 15, 2018 and will continue until the position is filled. A background check is required for employment in this position. Purdue University's Department of Earth, Atmospheric, and Planetary Sciences is committed to advancing diversity in all areas of faculty effort, including scholarship, instruction, and engagement. Candidates should address at least one of these areas in their cover letter, indicating their past experiences, current interests or activities, and/or future goals to promote a climate that values diversity and inclusion.

Purdue University is an EOE/AA employer. All individuals, including minorities, women, individuals with disabilities, and veterans are encouraged to apply.

ASSISTANT PROFESSOR
HYDROGEOLOGY
FORT HAYS STATE UNIVERSITY

Fort Hays State University seeks applications for a non-tenure-track Assistant Professor to start August 2018. Teaching duties include 12 credit hours per semester. The successful candidate must have expertise in hydrogeology or a closely related topic. Preference will be given to those who can teach structural geology as well as online courses.

A Ph.D. in Geology or closely related field is required (ABD considered). The Department offers B.S. and M.S. degrees. http://www.fhsu.edu/geo.

Only electronic applications submitted online are accepted:

https://fhsu.wd1.myworkdayjobs.com/CAREERS). Review of applications will begin on 16 February 2018.

EEO. Final candidate must pass a criminal background check.

URBAN METRO TRAVEL GRANT TO NEGSA 2018

Application deadline: 23 Feb.

Do you work full-time or care for dependents while earning your undergraduate degree? You may be eligible to apply for a travel award to attend the Northeastern Section Meeting (NEGSA), 18–20 March 2018 in Burlington, Vermont, USA. Check the student tab on the Northeastern Section website (www.geosociety.org/ne-mtg) for eligibility guidelines and an application. If you have questions, please email Tahlia Bear at tbear@geosociety.org.

The Geological Society of America®

GEOCAREERS

2018 GeoCareers Section Meeting Programs

Geoscience Career Workshops

For more information, contact Jennifer Nocerino at jnocerino@geosociety.org.

Part 1: Career Planning and Informational Interviewing. Your job-hunting process should begin with career planning, not when you apply for jobs. This workshop will help you begin this process and will introduce you to informational interviewing. This section is highly recommended for freshmen, sophomores, and juniors. The earlier you start your career planning the better.

Part 2: Geoscience Career Exploration. What do geologists in various sectors earn? What do they do? What are the pros and cons of working in academia, government, and industry? Workshop presenters and professionals in the field will address these issues.

Part 3: Cover Letters, Résumés, and CVs. How do you prepare a cover letter? Does your résumé need a good edit? Whether you are currently in the market for a job or not, learn how to prepare the best résumé possible. You will review numerous examples to help you learn important résumé dos and don'ts.

Mentor Programs

Enjoy a free lunch while meeting with geoscience mentors working in the applied sector. The popularity of these programs means that space is limited, so plan to arrive early, because lunch is first-come, first-served. For further information, contact Jennifer Nocerino at jnocerino@geosociety.org.

South-Central Section Meeting, Little Rock, Arkansas, USA
Shlemon Mentor Luncheon Program: Monday, 12 March
Mann Mentors in Applied Hydrology Luncheon: Tuesday, 13 March

Northeastern Section Meeting, Burlington, Vermont, USA
Shlemon Mentor Luncheon Program: Monday, 19 March
Mann Mentors in Applied Hydrology Luncheon: Tuesday, 20 March

Southeastern Section Meeting, Knoxville, Tennessee, USA
Shlemon Mentor Luncheon Program: Thursday, 12 April
Mann Mentors in Applied Hydrology Luncheon: Friday, 13 April

North-Central Section Meeting, Ames, Iowa, USA
Shlemon Mentor Luncheon Program: Monday, 16 April
Mann Mentors in Applied Hydrology Luncheon: Tuesday, 17 April

Rocky Mountain & Cordilleran Joint Section Meeting,
Flagstaff, Arizona, USA
Shlemon Mentor Luncheon Program: Tuesday, 15 May
Mann Mentors in Applied Hydrology Luncheon: Wednesday, 16 May

For photo credits, see inside back cover.

THE GEOLOGICAL SOCIETY OF AMERICA®

John W. (Jack) Hess, *GSA Foundation President*

Meet Our Newest Board of Trustee Members

GSA Foundation Board of Trustees.

The GSA Foundation Board of Trustees ensures transparent, cost-effective operations and open communication with the Society, as well as prudent fund management. We are pleased to introduce the newest members joining the prominent and dedicated geologists who govern the Foundation.

Terri Bowers is past president of Gradient, an environmental and risk science consulting firm in Cambridge, Massachusetts, USA. Her more than 30 years of experience in exposure modeling, mathematical and geochemical modeling, and the application of this information to risk-based environmental strategies and development of site-specific cleanup levels have included authoring an adult blood-lead model being used by the U.S. Environmental Protection Agency. Prior to joining Gradient, Dr. Bowers held research and visiting faculty positions at the Massachusetts Institute of Technology and Harvard University.

Rex Buchanan, director emeritus of the Kansas Geological Survey, is currently the director of the Consortium to Study Trends in Seismicity at the survey. In addition to serving as secretary of the Association of American State Geologists and past roles as president of the Kansas Association for Conservation and Environmental Education, the Kansas Academy of Science, and the Association of Earth Science Editors, his GSA involvement includes past chair of the Geology and Public Policy Committee, being named a Fellow in 2008, and receiving GSA's Public Service Award in 2016.

Steve Enders is the principal consultant for Renaissance Resource Partners, providing strategic advice for both the mining industry and for university economic geology and mining engineering programs worldwide. With 35 years of experience in the mining industry, including leading worldwide exploration for Phelps Dodge and Newmont, Steve brings a helpful industry perspective to the board. He currently serves as head of the Geology and Geological Engineering Department at the Colorado School of Mines.

Randy Keller, former GSA councilor, is a professor emeritus in the School of Geology and Geophysics at the University of Oklahoma. He also served as department chair at the University of Texas at El Paso, and joins the board with a breadth of experience that includes roles as director of the Oklahoma Geological Survey and State Geologist, and currently in consulting and as the North America representative for Seismik s.r.o. Randy has interests in geoinformatics, database development, and Web services useful to both academic and industry groups.

We are pleased to welcome **Mike Manship** back onto the GSAF Board of Trustees. Currently owner of Rock World LLC in Bozeman, Montana, USA, Mike served as treasurer of the board from 2006 through 2011. He brings institutional knowledge and history to the current slate of members, particularly important since several long-time board members recently completed their terms of service.

Steve Wells is president of the New Mexico Institute of Mining and Technology. Since he leads the university's fundraising efforts amidst all other duties, we value the development experience he has to contribute to our efforts. During his 17-year tenure as president of the Desert Research Institute, he led the organization as it doubled in operations. His earlier background in academia included roles at the University of California and the University of New Mexico. Steve's GSA involvement ranges from president of the Society, to Fellow, and to chair of the Quaternary Geology and Geomorphology Division.

GSA and AGU Fellow **Ellen Wohl** is a university distinguished professor in Colorado State University's Department of Geosciences, where she has been on the faculty since 1989. Much of Ellen's work has focused on mountain streams and rivers in bedrock canyons; she was part of the 2014 town hall that was hosted by the City of Boulder in partnership with GSA, "The Boulder Flood: One Year Later," a dialogue about climate, geology, and social behaviors related to the 2013 flood.

We are grateful to these new members and value the unique skills and insights each brings to our vibrant Board of Trustees.

GSA Section Meetings

2018

South-Central Section
12–13 March
Little Rock, Arkansas, USA
Meeting Chair: Michael DeAngelis, mtdeangelis@ualr.edu
www.geosociety.org/sc-mtg
Photo by Oliver Beland.

Northeastern Section
18–20 March
Burlington, Vermont, USA
Meeting Chairs: Charlotte Mehrtens, cmehrten@uvm.edu; Andrea Lini, alini@uvm.edu
www.geosociety.org/ne-mtg
Photo by Stephen Wright.

Southeastern Section
12–13 April
Knoxville, Tennessee, USA
Meeting Chair: Colin D. Sumrall, csumrall@utk.edu
www.geosociety.org/se-mtg
Photo by Bruce McCamish.

North-Central Section
16–17 April
Ames, Iowa, USA
Meeting Chair: William Simpkins, bsimp@iastate.edu
www.geosociety.org/nc-mtg
Photo by Bri Gerke.

Rocky Mountain/Cordilleran Joint Section Meeting
15–17 May
Flagstaff, Arizona, USA
Meeting Chair: Paul Umhoefer, paul.umhoefer@nau.edu
Meeting Co-Chair: Dennis Newell, dennis.newell@usu.edu
www.geosociety.org/rm-mtg
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THE GEOLOGICAL SOCIETY OF AMERICA®

SCIENCE EDITOR OPENINGS FOR 2019

GSA is soliciting applications and nominations for science co-editors with **four-year terms beginning 1 January 2019.** Duties include: ensuring stringent peer review and expeditious processing of manuscripts; making final acceptance or rejection decisions after considering reviewer recommendations; and maintaining excellent content through active solicitation of diverse and definitive manuscripts.

POSITIONS AVAILABLE If applicable, research interests that complement the continuing editors are listed.

ENVIRONMENTAL & ENGINEERING GEOSCIENCE Hydrogeology; low-T geochemistry; geomorphology; and/or environmental geophysics.

GSA BOOKS Editor duties include soliciting high-quality book proposals and ensuring proper peer review procedures. The successful candidate will have a wide range of interests and expertise, prior editing experience, and a strong publication record.

LITHOSPHERE Tectonics and structural geology; geomorphology and neotectonics; metamorphic geology.

GSA BULLETIN Deformation; geochemistry; paleoclimatology; Precambrian geology; seismology; stratigraphy; structural geology; volcanology.

GSATODAY, one of the most widely read earth science publications in the world, seeks an editor who has a wide range of interests and expertise, the ability to identify research topics of both high quality and broad appeal, a strong publication record, and prior editing experience.

GEOSPHERE Deformation; geodynamics; geophysics; marine geophysics; seismology; structural geology; tectonics; geodesy; tectonophysics.

Note that candidates should not feel they must have expertise in *every* area listed; however, editors will sometimes need to handle papers outside of their main disciplines.

E&EG ▸ 1 position

GSA Books ▸ 1 position

Lithosphere ▸ 1 position

GSA Bulletin ▸ 1 position

GSA Today ▸ 1 position

Geosphere ▸ 1 position

A SUCCESSFUL EDITOR WILL HAVE

- a broad interest and experience in geosciences, including familiarity with new trends;
- international recognition and familiarity with many geoscientists and their work;
- a progressive attitude and a willingness to take risks and encourage innovation;
- experience with online manuscript systems and the ability to make timely decisions; and
- a sense of perspective and humor.

INTERESTED?

- Submit a curriculum vitae and a letter describing why you (or your nominee) are suited for the position to Jeanette Hammann, jhammann@geosociety.org.

Editors work out of their current locations at work or at home. The positions are considered voluntary, but GSA provides an annual stipend and funds for office expenses. **DEADLINE:** First consideration will be given to nominations or applications received by **15 February 2018**.

FUTURE OPENINGS (terms begin January 2020):
GSA Bulletin (one position), *Geology* (two positions), *Lithosphere* (one position), GSA books (one position).